A TAXONOMIC REVISION OF PODOCARPUS
X. THE SOUTH PACIFIC SPECIES OF SECTION EUPODOCARPUS, SUBSECTION D

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THE SPECIES AND VARIETIES of *Podocarpus* in subsection D of section *Eupodocarpus* are: *Podocarpus totara* D. Don, *P. hallii* Kirk, *P. nivalis* Hooker, *P. nivalis* var. *erectus* Cockayne, *P. acutifolius* Kirk, *P. alpinus* R. Brown, *P. gnidioides* Carrière and *P. nubigenus* Lindley. All of these are found in southern regions of the Pacific Ocean. Of the species growing in the southwest, all are found on the large islands: New Zealand, New Caledonia and Tasmania. *Podocarpus alpinus*, on Tasmania, is also found in the southeastern part of the continent of Australia. *Podocarpus nubigenus* is the only one of these species growing on the American side of the Pacific; it is found in the mountainous regions of southern Chile and, incidentally, has the southernmost range of any podocarp. Orr (15), using only geographical groups in the section *Eupodocarpus*, discussed *P. gnidioides* and *P. nubigenus* as exceptions in their areas. However, in his discussion of the New Zealand members, he emphasized the similar characteristics of all of them. The interesting distribution of these species, in the southern parts of South America and Australia and in New Zealand, is also found in other groups of plants and is considered when theories of land bridges or continental drift are under discussion (2).

Podocarpus totara, *P. hallii* and *P. nubigenus* are the only species with tree habit and large enough to be of some use in industry. *Podocarpus acutifolius* and *P. nivalis* var. *erectus* are erect but shrubby. *Podocarpus gnidioides*, *P. alpinus* and *P. nivalis* are low shrubs often having prostrate or decumbent branches. They are all small-leaved, exceeding 2 cm. in length only in *P. hallii* and *P. nubigenus* and exceeding 3.5 mm. in width also in *P. totara*. The small, crowded leaves, together with the low shrubby nature of several of the species, make the taxoid appearance of these plants quite apparent. The ridges on the twigs, formed by the decurrent petioles, are less prominent in *P. totara* and *P. hallii* and the leaves are not so densely crowded.

In the leaf anatomy one can see that these species belong in section *Eupodocarpus*. Some of the characters in common with other members of this section are a single midvein, stomata only on the lower surface, varying amounts of hypoderm on both sides and palisade mesophyll only on the upper side of the leaf.

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All of these species differ in their leaf anatomy from the rest of section *Eupodocarpus* by the absence of an organized accessory transfusion tissue. The lignified elements in the mesophyll, representing the accessory transfusion tissue, show variation both in the degree of lignification of single cells and in the number of cells in which the walls are so thickened. Juvenile and young leaves may not show any thickening of mesophyll cell walls, while mature leaves from exposed situations and from fruiting branches may have adjacent cells extending from the vascular transfusion tissue to the margin of the blade of the leaf. *Podocarpus gnidioides* shows these cells loosely arranged in a tissue (15, pl. 2, fig. 6) but they can scarcely be said to be oriented transversely to the blade of the leaf as in *P. totara*. Among these species, *P. gnidioides* has the most thickening and *P. acutifolius* the least. These lignified elements resemble those of section *Afrocarpus* rather than typical accessory transfusion tissue. Griffin (12) made a study of their development in *P. totara* and regarded them as belonging to true accessory transfusion tissue. However, Orr (15) speaks of this as a "misnomer" and considers them only as strengthening units similar to the lignified, pitted cells found in the mesophyll and palisade of section *Eupodocarpus* subsections A, B and C, rather than conducting elements even though here in subsection D they have not been found in either of the mentioned positions. Entertaining Orr's view, subsection D would not have accessory transfusion tissue. A dual role, conduction and support, is usually understood for lignified, pitted elements in vascular tissues. It hardly seems necessary in this case to ascribe one of these functions to auxiliary sclereids for all species to the complete exclusion of the other. Certainly even transversely oriented parenchyma cells also serve in conduction. These cells with thickened walls, regardless of number, often retain protoplasmic substances. The cells derive their origin from differentiating mesophyll whether they are true organized accessory transfusion tissue, isolated sclereids in the same location in the leaf, or auxiliary sclereids among or adjacent to the palisade tissue. This has very recently been observed by Griffith (13) while studying the ontogeny of vascular transfusion tissue in *Podocarpus macrophyllus*. A review of the literature relating to accessory transfusion tissue is to be found in Orr (15).

The single resin canal beneath the phloem varies considerably in size. It seems to be consistently small in *Podocarpus acutifolius*, large in *P. nivalis*, *P. gnidioides* and *P. alpinus*, but in *P. totara* and *P. hallii* it is found to vary from half the width of the vascular bundle to fully as wide.

The hypodermal fibers are mostly small. In *Podocarpus totara*, *P. hallii*, *P. nivalis* and *P. alpinus* they vary from 17–25μ in diameter, seldom more than 15μ in *P. acutifolius*, and often more than 30μ in *P. gnidioides*. They are arranged in a single upper layer except at the margins in *P. acutifolius*. The layer is sometimes doubled and usually is interrupted in *P. alpinus* and *P. nivalis*, but mostly continuous in *P. totara* and *P. hallii*. Hypodermal fibers are found between the stomatal rows in all species but *P. gnidioides* and are most abundant in *P. totara* and *P. hallii*.

True fibers between the phloem and the resin canal were found in several leaves of *Podocarpus totara* and *P. alpinus*. Such fibers, however, are exceedingly rare in this subsection. In some of the other species, the mesophyll cells surrounding the vascular bundle seem to be differentiated in having denser cell contents or slightly thickened walls, but never by being enlarged.

The species in this group do not have bracts on the peduncle of the female cone below the receptacle, suggesting a closer relationship to subsection C in South America than to those species in the western south Pacific region. The single resin canal beneath the phloem is also characteristic of both subsections. Pilger (17) divides section *Eupodocarpus* into two subsections, A and B. In his subsection A he groups all the American species of *Eupodocarpus* and the species included in subsection D in this study.

Concentrated studies on the New Zealand conifers have been made and the polymorphism of many of them led to the early recognition and study of hybridization in the wild flora. This was found to account for the intergrading varieties between *Podocarpus totara* and *P. hallii*, two large trees, by Cockayne (6) and *P. hallii* and *P. nivalis*, a tall tree and a depressed shrub. A likely result of the latter cross may be *P. nivalis* var. *erectus* which has not yet been recognized as a hybrid. The former was named *P.* × *loderi* by Cockayne, but he considered it too early to present a definite name for the latter.

This subsection of *Eupodocarpus* has had the most extensive investigation of chromosome number (18). *Podocarpus acutifolius*, *P. alpinus* and *P. nivalis* agree with the other members of section *Eupodocarpus* in having n = 19. Burlingame is quoted as saying *P. hallii* has n = 12 but this bears reinvestigation as other counts made by this author have been incorrect.*

The taxonomy of *Podocarpus nubigenus* is not repeated in this paper as it was included with the species of section *Eupodocarpus* from South America (3).

KEY TO THE SPECIES OF SECTION EUPODOCARPUS, SUBSECTION D

Leaves pungent-mucronate; trees or shrubs.
- Leaves 1–4 cm. (rarely 6 cm.) long; trees.
  - Leaves 2–3.5 mm. broad; bark thick; male flowers rarely solitary, subsessile; seed obtuse — *P. totara*.
  - Leaves 3–6.5 mm. broad; bark papery; male flowers solitary, peduncled; seed acute — *P. hallii*.
- Leaves 0.6–2.5 cm. long; shrubs.
  - Leaves thick, coriaceous; hypoderm interrupted; resin canal large.

* A recent communication from Dr. J. B. Hair, Crop Research Division, New Zealand, indicates that the chromosome counts of several of these species, when taken from native material, differ from the counts quoted above. He finds that the 2n chromosome number is 34 for *P. totara*, *P. hallii*, and *P. acutifolius*, 38 for *P. nivalis* and 36 for *P. nivalis* var. *erectus*.

Prostrate branches; leaves not over 1.5 cm. long. ..... *P. nivalis.*
Erect branches; leaves up to 2.5 cm. long ..... *P. nivalis* var. *erectus.*
Leaves thin, coriaceous; hypoderm continuous; resin canal small. ..... *P. acutifolius.*
Leaves obtuse or rotundate at apex, not pungent; shrubs.
Upper midrib of leaves flattened; pollen cones facicled 3–6; hypoderm interrupted, single layer, fibers small ..... *P. alpinus.*
Upper midrib sulcate; pollen cones solitary; hypoderm continuous, doubled, fibers large ..... *P. gnidioides.*

Podocarpus totara D. Don ex Lamb. Pinus ed. 2, 189. 1832; A. Cunn. in Ann. Nat. Hist. 1: 212. 1838 (excl. synon.); D. Don ex Hooker in Lond. Jour. Bot. 1: 572. 1842; Raoul, Choix Pl. Nouv. Zél. 41. 1846; Endlicher, Syn. Conif. 212. 1847; Hooker f., Fl. Nov. Zealand 1: 233. 1853, Handb. N. Z. Fl. 258. 1864; Gordon, Pinetum 285. 1858, ed. 2, 350. 1875; Carrière, Traité Conif. ed. 2, 652. 1867 (excl. var.); Parlatore in DC. Prodr. 16: 514. 1868; Bertrand in Ann. Sci. Nat. ser. 5, 20: 59. 1874; Mahlert in Bot. Centralbl. 24: 280. 1885; Kirk, Fl. N. Zealand 227. 1889; Kent in Veitch's Man. Conif. 153. 1900; Van Tieghem in Bull. Soc. Bot. France 38: 169. 1891; Pilger in Pflanzenreich **IV. 5**(Heft 18): 84. 1903, in Nat. Pflanzenfam. ed. 2, 13: 248. 1926; Cheeseman, Man. New Zealand Fl. ed. 1, 638. 1906, ed. 2, 111. 1925; Griffin in Trans. N.Z. Inst. 40: 43. 1907; Cockayne, Veg. N. Z. in Engler & Drude, Veg. der Erde, *t. 28.* 1921, *t. 22.* 1928; Bailey, Cult. Evergreens 180. 1923; Dallimore & Jackson, Handb. Conif. 56. 1923, 1931, 83. 1948; Florin in Svenska Vet.-Akad. Handl. ser. 3, 10: 280. 1931; Laing & Blackwell, Pl. of N. Z. ed. 4, 66. 1940.

Podocarpus bidwillii Hoibrenk in Endlicher, Syn. Conif. 213. 1847.

Podocarpus cunninghamii Colenso, Visit to Ruahine Range 58. 1844.

A large tree, 10–30 m. or more high, trunk 0.5–2 m. in diameter, with thick bark; the short, sometimes thickly leafy branchlets scattered or subverticillate, green, scarcely ridged. Terminal buds 1.2–1.5 mm. wide, globose or ovate, with 2 series of bud scales usually sharply differentiated, the outer scales lanceolate, sometimes foliaceous, up to 3 mm. long, acute, attenuate, tips usually divaricate, green; inner imbricate, curving over growing tip, apiculate, ovate, brownish, margins scarious and erose. Leaves spreading scattered or arranged in 2 rows, 1–2 cm. long, 2.5–4 mm. wide, linear, rigid and coriaceous, very thick, pungent, narrowed at both ends, sharply pointed, straight or curved, sessile (juvenile leaves not essentially different); midrib not evident or only shallowly impressed above, clearer beneath. Pollen cones axillary, subsessile, fascicled 2 or 3, or at end of a short thick peduncle 1–2 mm. long (rarely solitary according to Kirk), base surrounded by stiff broad scales, erect, cylindrical, 1.5 cm. long, 3 mm. broad. Microsporophylls closely imbricate, rhomboidal, with a short obtuse apiculus, scarious margined, and sparingly denticulate. Female cones solitary, axillary, on short peduncles 2–3 mm. long; recep-

tacle of 2–4 fused fleshy scales, the upper ones not well developed, free at tip, subglobose and red when mature. Seeds 1 or 2 but usually solitary, small, subglobose, obtuse or rounded at apex, 10–12 mm. long.

DISTRIBUTION: New Zealand, on both North and South Islands, on slopes from sea level to 650 m., reaching largest size at 400 m. altitude. Not on Stewart Island.

In 1889, Kirk (14) distinguished *Podocarpus totara* from his new species, *P. hallii*, morphologically and geographically. In the former species the branchlets are always stiff and rigid, even in immature plants; the leaves do not differ in the young state from the mature leaves, the sessile male cones are rarely solitary and the seed is rounded at the apex and usually solitary. Thus he restricted the description somewhat from that of Pilger (16) which was written to include both species. In a short summary differentiating these two species, Kirk seems to have erred by reversing the mature leaf size which, for *P. totara*, is smaller in most cases, rarely exceeding 2 cm. in length and only reaching 3 mm. in width.

The cultivated specimen at Kew, known as *Podocarpus totara*, has rigid leaves which taper gradually toward the apex and suggest that it may rather be *P. hallii*, or a hybrid. *UC10423*, collected by Setchell in 1904, was determined by Cheeseman as *P. totara*, but it exceeds all specimens of this species seen in the size of the leaves.

There has been some minor confusion in the form of the name and its source. Don (10) first used the native name Totara to designate the species in 1832. Cunningham again described it in 1838 (8), calling it *Podocarpus totara*, the form used by New Zealand authorities Cockayne (6), Cheeseman (5), Kirk (14), and Pilger (17). The name is sometimes credited to A. Cunningham, but, following the International Code, it should be to D. Don as the earliest publication of the name.

SPECIMENS EXAMINED: *

NEW ZEALAND: North Island: Whangarei, *Kirk s.n.* (A, †F, †Mo, UC), *Kirk s.n.* (GH), *McLeod* in 1913 (†UC), *Cunningham 328* (TYPE) (†BR, K), Ruatangata, *Gordon* in 1910 (K–4 sheets); Bay of Islands, *Capt. Home s.n.* (†BM); *Matthews* in 1905 (†UC); Wellington, *Lawton s.n.* (†Ill). South Island: Otira Luga, *Kirk 467* (GH); Canterbury, *Adams* in 1914 (A); Woodbury, *Meebold 4059* (NY); Dunedin, *Meebold 4257* (NY); Mt. Martii, *Haast* in 1866 (†BR); Waya-runa Bay, U.S. So. Pac. Expl. Exped., *Anon.* in

* The following symbols indicate the herbaria of the specimens cited: Academy of Natural Sciences of Philadelphia (Ph), Arnold Arboretum (A), British Museum (BM), Brussels Botanical Garden (BR), University of California at Berkeley (UC) and at Los Angeles (LA), California Academy of Science (CAS), Chicago Natural History Museum (Field Museum) (F), Cornell University (CU), Gray Herbarium (GH), University of Illinois Herbarium (Ill), Royal Botanic Gardens, Kew, (K), Missouri Botanical Garden (Mo), New York Botanical Garden (NY), Paris Museum National d'Histoire Naturelle (P), Yale University Herbarium (YU).

† This symbol preceding the abbreviated name of an herbarium following the specimens examined signifies that the details of the leaves of this specimen have been examined in cross-section.

1838 (GH). LOCALITY NOT INDICATED: *Colenso* 1631 (K), *Colenso* for J. D. Hooker (K), *J. D. Hooker* (K), *Colenso s.n.* (K).

CULTIVATED: Hontika, *Wilson* in 1921 (A); England, Royal Botanic Garden at Kew, *Anon.* in 1857 (†Mo), *Cook* in 1937 (†Ill); Italy, Botanic Garden, Naples, H.13, *Cestai* to Engelmann in 1870 (†Mo–3 sheets), *Anon.* in 1868 (Mo); U.S. California, Golden Gate Park, *Collins* in 1918 (YU), *Eastwood* in 1913 (CAS), in 1914 (A), in 1916 (A–2 sheets, CAS), *Walther* in 1924 (A), *Buchholz* in 1942 (†Ill), Santa Barbara, *Van Rensselaer 1725* (†Ill).

Podocarpus hallii Kirk, Forest Fl. N. Z. 13. 1889; Cheeseman, Man. N. Z. Fl. 648. 1906, ed. 2, 111. 1925; Cockayne, Veg. N. Z. in Engler & Drude, Die Veg. der Erde 111. 1921, 1928; Pilger in Nat. Pflanzenfam. ed. 2, **13**: 247. 1926; Florin in Svenska Vet.-Akad. Handl. ser. 3, **10**: 279. 1931.

Podocarpus totara var. *hallii* (Kirk) Pilger in Pflanzenreich **IV. 5**(Heft 18): 84. 1903; Dallimore & Jackson, Handb. Conif. 57. 1923, 1931, 83. 1948.

A tall tree, 8–20 m. high, 0.5–1 m. in diameter, with thin papery bark; juvenile plants slender, the branchlets at right angles to main axis or often pendulous. Terminal buds slightly larger than twig, all scales broadly ovate, margins scarious and erose, obtuse and sometimes apiculate. Leaves on mature plants 2–4 cm. long, 1.5–3.5 mm. wide, linear, rigid, coriaceous, close-set in several series, erect, pale green when dry, narrowed at base into a very short flat petiole, tips pungent; midrib prominent beneath. Juvenile leaves 2-ranked, larger than mature leaves, 2–6.8 cm. long, 4–5 mm. wide, lanceolate, spreading, often abruptly narrowed at the base and very gradually narrowing to the apex. Pollen cones sessile, solitary (according to Kirk, 14) on distinctly stalked peduncle. Microsporophylls short, broad, apiculate. Female cones solitary on 2–3 mm. long peduncles; receptacle of 2–4 fused fleshy unequal scales free at acute tips, red at maturity, subglobose. Seed acute, pointed at apex, crested, often in 2's, 1–1.2 cm. long.

DISTRIBUTION: Endemic in New Zealand, most abundant on South Island and especially on Stewart Island, sea level to 950 m.

Several times the specific designation has been used in varietal status. Cheeseman (5), after listing it as a species, says "the variety designation might be right but the bark difference is significant." Pilger (16) lists, but questions, *Podocarpus laeta* Hoibrenk as a synonym of *P. totara* var. *hallii*. Endlicher (11) gives the locality for this species as New Holland (Australia) making the combination most improbable, and its correct position cannot be determined without the type specimen.

At the Royal Botanic Gardens, Kew, is an herbarium specimen said to be from a living specimen believed to be a hybrid of *Podocarpus hallii* and *P. nivalis* brought to Kew from Beech Forest, Bealey Valley, N. Z.*

* The living specimen was not seen in 1950 by Prof. Buchholz on his visit to the garden.

SPECIMENS EXAMINED:

NEW ZEALAND: North Island: Ruatangata, *Setchell* in 1904 (†UC–2 sheets); Kartaria, Mongonni Creek, Carse (K); Bay of Islands, U.S. So. Pac. Exped., *Anon.* (GH); Te Aroha, *Chase & Leland 276b* (†Mo); Ruahine Mts., *Tryon s.n.* (A); *Kirk s.n.* (A). South Island: Clinton Valley, *Cockayne 6648*, *Petrie* (NY); Dunedin, Leith Valley, *Lindsey* in 1935 (CU); Westport, *Townson s.n.* (K); Otira Gorge, *Oliver s.n.* (K). Stewart Island: *Cockayne 6661* (†F–2 sheets), *Kirk s.n.* (†F, GH, †Mo). LOCALITY NOT INDICATED: Flea Bay, *Karva* in 1910 (†A); ex Masters Herb., *Anon.* (K); *Morhange s.n.* (†BR); ex Prager Herb., *Anon.* (CAS); *Prince* in 1898 (GH).

CULTIVATED: England, Roy. Bot. Gard., Kew, *Cook* in 1937 (†Ill); Australia, *Hennings* in 1885 (Mo); U.S., California, Greendale, *Anon.* (A); Golden Gate Park, San Francisco, *Eastwood* in 1916 (CAS), in 1917 (CAS), *Walther* in 1921 (CAS), in 1923 (A), in 1924 (A).

Podocarpus nivalis Hooker, Icon. Pl. pl. 582. 1843; Raoul Choix Pl. Nouv. Zél. 41. 1846; Endlicher, Syn. Conif. 214. 1847; Hooker, f., Fl. N. Z. 232. 1853, Handb. N. Z. Fl. 257. 1864; Carrière, Traité Conif. ed. 2, 655. 1867; Parlatore in DC. Prodr. **16**: 519. 1868; Mahlert in Bot. Centralbl. **24**: 280. 1885, Kirk, For. Fl. N. Z. 65. 1889; Pilger in Pflanzenreich **IV. 5** (Heft 18): 85. 1903, in Nat. Pflanzenfam. ed. 2, **13**: 247. 1926; Cheeseman, Man. N. Z. Fl. 649. 1906, 112. 1925; Cockayne, Veg. N. Z. 1921, 1928; Dallimore & Jackson, Handb. Conif. 53. 1923, 1931, 78. 1948; Florin in Svenska Vet.-Akad. Handl. ser. 3, **10**: 279. 1931; Laing & Blackwell, Pl. N. Z. 66. 1940.

Podocarpus montanus Colenso in Trans. N. Z. Inst. **27**: 395. 1895.

A suberect shrub with numerous crowded, rigid branches, 0.5–2.5 m. high in sheltered situations or a low bush with spreading prostrate rigid branches which give off roots from the under surface in more open areas. Branchlets short, thickly leafy, ridged from pulvini at bases of sessile leaves and prominent leaf scars. Terminal buds globose with short greenish, broadly lanceolate, keeled, acute, scarious-margined, erose outer scales; on seedlings more ovate with triangular scales. Leaves vary in size, the larger in the middle of a growth period, thick and coriaceous, very stiff, linear, 0.9–1.5 cm. long, 2–2.5 mm. wide (2.5 cm. long on seedlings), patent, gradually narrowed to base, abruptly obtuse or acute at apex, mucronate, sessile or only very short stalked; midrib prominent below, stout, slightly impressed above giving a folded appearance; margin of blade thickened. Pollen cones fascicled, 2–4 at tip of common peduncle (sometimes solitary according to Dallimore & Jackson, 9), 3–5 mm. long, surrounded at base by minute stiff bracts decurrent on peduncle to leaves, narrowly cylindric, 1 cm. long. Microsporophylls closely imbricated, apiculus scarcely evident. Female cones solitary, axillary, peduncle very short, 1 mm. long, thick; receptacle of two fused fleshy scales free at the obtuse tips, 3–7 mm. long. Seed ovoid, obtusely crested, 5–6 mm. long.

DISTRIBUTION: Endemic on North and South Islands of New Zealand

but not on Stewart Island. Restricted to alpine and subalpine localities, 650–1800 m. altitude.

Podocarpus nivalis is locally known as the Alpine Totara. Its spreading branches are dense and produce a characteristic appearance in the low, thick and often very large amount of ground covered by a single plant.

SPECIMENS EXAMINED:

NEW ZEALAND: North Island: Mt. Ngauruhoe, *Cheeseman s.n.* (K); Ruahine Mts., *Tryon s.n.* (A, †LA); Ruapehu, *Meebold 17905* (NY), ex Masters Herb., *Anon.* (K–2 sheets); *Bidwell s.n.* (†K). South Island: Mt. Movatt, *Kirk 468* (GH); Hooker Valley, Mt. Cook Dist., *Cheeseman 186* (K); Greenstone Valley, Totago, *Haast 49* (K); near Brownings top, *Haast 67* (K); Mt. Whitnomber, *Haast 104* (K); Valley of Camerons near Hawthe Glacier, *Haast 105* (K); on Old Morarius, near Cumuo, *Haast 109* (K); Canterbury, *Haast 541* (K); Mt. Bruce, *Kirk s.n.* (A, †F, †Mo, NY); Arthur's Pass, Southern Alps, *Cockayne 6645* (†CAS, NY); Clarence Valley, *Hector s.n.* (GH); Mt. Martii, *Haast* in 1866 (†BR–2 sheets). LOCALITY NOT INDICATED: *Colenso 966, 991, 1552, s.n.* (K).

CULTIVATED: Wellington, *Gunn 226* (GH). South Island, Park Gardens, *Anderson 85* (†F), *86* (A, †Mo, NY, Ph, UC).

Podocarpus nivalis Hooker var. **erectus** Cockayne in Trans. N. Z. Inst. **48**: 199. 1916; Cheeseman, Man. N. Z. Fl. 112. 1925.

An erect shrub, 1–2 m. high. Leaves larger, sometimes nearly 2.5 cm. in length. Otherwise like the species proper. This form is found in a restricted area on South Island, but also appears in cultivation.

DISTRIBUTION: South Island, 1000 m. on Mt. Owen and Mt. Percival in Nelson Province and Cass River, Canterbury.

SPECIMENS EXAMINED:

NEW ZEALAND: South Island: Mt. Sugarloaf, Cass, *Foweraker & Cockayne 20000* (TYPE) (†A–2 sheets); Southern Alps, Canterbury, Big Ben, *Cockayne 189* (†GH); Hermitage, Mt. Cook region, *W.A. & C. B. Setchell* in 1927 (UC); ?Bay of Islands, U.S. So. Pac. Expl. Exped., *Anon. s.n.* (GH).

CULTIVATED: California, Golden Gate Park, *Eastwood* in 1916 (CAS), *Walther* in 1920 (CAS), in 1923 (A), in 1924 (A), *Walker 5165* (UC).

Podocarpus acutifolius Kirk in Trans. New Zealand Inst. **16**: 370. 1883, For. Fl. N. Z. 64. 1889; Pilger in Pflanzenreich **IV. 5**(Heft 18): 84. 1903, in Nat. Pflanzenfam. ed. 2, **13**: 247. 1926; Cockayne, Veg. N. Z. 1921, 1928; Florin in Svenska Vet.-Akad. Handl. ser. 3, **10**: 279. 1931.

Podocarpus parvifolius Parlatore in DC. Prodr. **16**: 514. 1868; Dallimore & Jackson, Handb. Conif. 54. 1923, 1931, 79. 1948.

An erect-branched shrub, 1–2 m. high, branches short and rigid (in sheltered places slender), erect. Branchlets 1–1.2 mm. in diameter, green, ridged, leaf scars prominent. Terminal buds ovate, no wider than stem,

with scales lanceolate, attenuate, tip stiff and thick, base broad, with scarious erose margins. Leaves crowded (spreading and lax in sheltered places), thin, green, 1–1.5 cm., or more long, 1.5–2 mm. wide (rarely 2.5 mm.), coriaceous, narrow-linear, long-angustate, pungent; midrib prominent beneath, flat above; stomata in 2 whitish bands on underside. Pollen cones 1 or 2 (or more) fascicled on a short peduncle, each cone surrounded at base by 4 ovate acute-obtuse, broad, scarious-margined scales, 2.5 cm. long. Microsporophylls obtuse. Female cones solitary, axillary, on very short 1 mm. peduncles; receptacle of 2 or 3 fused unequal fleshy scales, the larger scale fertile, free at the obtuse tips, red. Seed narrow-ovoid, 4 mm. long, 3 mm. wide, crested.

DISTRIBUTION: Mountain districts in Marlborough, South Island. Known as the Acute-leaved Totara.

SPECIMENS EXAMINED:

NEW ZEALAND: South Island: Hope Valley, *Kirk s.n.* (A, †F, GH, †Mo); Canterbury, *Haast* in 1866 (†BR); Lake Rotoit, Nelson, *Cheeseman s.n.* (Ph.), *Anon.* ex Gordon Herb. (A); Lake Rolaiti, *Cheeseman s.n.* (K); Lake Brunner Dist., Westland, *Cockayne 6646* (A, NY); Glenhope, *Cockayne 8555* (A); Western Botanic Dist., near Waiko, *Cockayne 10022* (A–2 sheets); Omerva Saddle, *Cockayne 10020* (A); Mt. Duppa, Marlborough, *Sledge 247* (CU); Nothopip forest, Marcuia Valley, *Cockayne 13579* (K); ex Masters Herb., *Anon. s.n.* (K).

CULTIVATED: New Zealand: North Island, Ruatangata Garden, *Setchell* in 1904 (†UC, 1–2 yr. seedlings); South Island, Dunedin Botanic Garden, *Lindsey* in 1935 (CU–2 sheets). England: Kew, Royal Botanic Garden, *Cook* in 1937 (†Ill–2 sheets). United States: California, Golden Gate Park, *Eastwood* in 1916 (CAS), in 1919 (CAS), *Walther* in 1920 (†CAS), Greendale, *Anon. s.n.* (A).

Podocarpus alpinus R. Brown ex. Mirb. Geogr. Conif. in Mém. Mus. **13**: 75. 1825 (nomen!); Bennett in Horsfield Pl. Jav. Rar. 40. 1838 (nomen!); Hooker f. in Lond. Jour. Bot. **4**: 150. 1845, Fl. Tasmania **1**: 356. 1860; Endlicher, Syn. Conif. 214. 1847; Parlatore in DC. Prodr. **16**: 520. 1868; Bentham, Fl. Australia **6**: 248. 1873; Mahlert in Bot. Centralbl. **24**: 280. 1885; Kent in Veitch's Man. Conif. 148. 1900: Pilger in Pflanzenreich **IV. 5** (Heft 18): 83, f. 16E, 85. 1903, in Nat. Pflanzenfam. ed. 2, **13**: 218, f. 117E, 247. 1926; Baker & Smith, Res. Pines of Australia 442. 1910; Dallimore & Jackson, Handb. Conif. 38. 1923, 1931, 60. 1948.

Nageia alpina F. Müller in Pap. Roy. Soc. Tasmania 23. 1879.

Podocarpus alpina var. *lawrencii* Hooker f., Fl. Tasmania **1**: 356. 1860.

Podocarpus lawrencii Hooker f. in Lond. Jour. Bot. **4**: 151. 1845.

Podocarpus totara var. *alpina* Carrière, Traité Conif. ed. 2, 652. 1867.

A low shrub up to 4 m. in height, densely branched; branchlets scattered, short, spreading, thickly leafy, greenish, ridged, with leaf scars raised on pulvini. Terminal buds ovate or globose, of the same diameter as the stem;

outer scales elongate, up to 2 mm. long, keeled, erect, tip thick and broad, becoming shorter with acuminate tip; inner scales thin, keeled, broadly triangular, brown, margins scarious and erose, short apiculate, often not deciduous. Leaves spreading, coriaceous, oblong-linear, shortly rotundate or obtuse at the tip, sometimes shortly subapiculate, gradually narrowing to the sessile base, 0.5–1.2 cm. long, 1.5–2.5 mm. broad; midrib flat or slightly impressed above, broad and prominent below. Pollen cones fascicled 3–6 (solitary and sessile according to Dallimore & Jackson, 9) at the tip of peduncles 3–4 mm. long (up to 1 cm.), in the axils of short scarious-margined bracts, these sometimes as long as the leaves, decurrent on peduncle, patent, cones 6 mm. long. Microsporophylls imbricate, crowded, triangular obtuse with fairly long apiculi. Female cones on very short peduncles or sessile; receptacle small, 3 mm. long, of two fused fleshy scales with rather long free tips. Seed ovoid, 5 mm. long (or less), crested.

DISTRIBUTION: High mountain regions in New South Wales of Australia and Tasmania.

SPECIMENS EXAMINED:

AUSTRALIA: New South Wales: Mt. Kosciusko, *Maiden & Forsyth* in 1899 (A, †CAS, †Mo, UC). Tasmania: Western Mts., *Rodway* in 1929 (†A); Mt. Field, east side, *Maiden* in 1906 (†A, †BR, GH); Mt. Wellington, *Gunn 226* (†GH, YU); Sasset, Border Hill, The Warren Wood, *Jackson* in 1936 (A); *Beunit 120* (TYPE) (†BM); *O.W.F. s.n.* (†BR); *Pibrin 4* (K); ex Gay Herb., *Anon. s.n.* (GH).

CULTIVATED: England: Kew, Royal Botanic Garden, *Nicholson 68* (A), *A.R.* in 1901 (A); ex Gordon Herb. *Anon. s.n.* (A). United States: California, Golden Gate Park, *Buchholz* in 1942 (†Ill).

Podocarpus gnidioides Carrière, Traité Conif. ed. 2, 656. 1867; Pilger in Pflanzenreich **IV. 5**(Heft 18): 82. 1903, in Nat. Pflanzenfam. ed. 2, **13**: 84. 1926; Schlechter in Bot. Jahrb. **39**: 16. 1907; Guillaumin in Ann. Musée Col. Marseille ser. 2, **9**: 269. 1911, in Bull. Mus. Hist. Nat. Paris **18**: 100. 1912, Fl. France D'Outre-Mer 10. 1948; Dallimore & Jackson, Handb. Conif. 46. 1923, 1931, 70. 1948; Florin in Svenska Vet.-Akad. Handl. ser. 3, **10**: 279. 1931.

Podocarpus gnidioides var. *caespitosa* Carrière, Traité Conif. ed. 2, 656. 1867; Pilger in Pflanzenreich **IV. 5**(Heft 18): 84. 1903; Compton in Jour. Linn. Soc. **45**: 426. 1922; Dallimore & Jackson, Handb. Conif. 46. 1923, 1931, 70. 1948.

Podocarpus alpina var. *aborescens* Brongniart & Gris in Bull. Soc. Bot. France **13**: 425. 1866; Dallimore & Jackson, Handb. Conif. 46. 1923, 1931, 70. 1948.

Podocarpus alpina var. *caespitosa* Brongniart & Gris in Bull. Soc. Bot. France **13**: 425. 1866.

A small shrub 0.5–2 m. high; branches decumbent, 1.2–1.5 mm. in diameter at tip, thickly leafy, green, ridged, with prominent leaf scars, the

bark becoming greyish, the inner bark brown. Terminal bud globose, flattened, 2 mm. in diameter, outer scales oblong or narrowly triangular, keeled, with thick tips erect or scarcely spreading, becoming shorter (1 mm. long), obtuse, with incurved tips; inner scales rotundate or broadly obtuse, scarious erose margined. Leaves quite spreading, linear, rounded to obtuse at the apex, sessile, gradually narrowing at the base, shiny above, very revolute margins when dry, 1.2–2 cm. long, 1–2 mm. broad; upper midrib shallowly grooved or abruptly sulcate, sometimes quite prominent below. Pollen cones axillary, solitary on peduncle 4 mm. long, erect, cylindric, surrounded at base by broad obtuse scales with scarious margins, 1–2 mm. long. Microsporophylls crowded, scarcely apiculate. Female cones solitary, axillary on short thick peduncle 1–1.5 mm. long; receptacle of 2 fused, almost equal, fleshy scales free at the broad obtuse tips, only 3–5 mm. long, bright red at maturity. Seed ovoid, crest erect, 5–7 mm. long, 3 mm. broad.

DISTRIBUTION: New Caledonia in summit flora of mountains.

SPECIMENS EXAMINED:

NEW CALEDONIA: Mt. Dore, *Pancher 397* (P), *Pancher & Vieillard 397* (P), Pancher ex *Thoret* (K), *Pancher s.n.* (P–3 sheets), Pancher ex *Hennecart* in 1879 (K, NY), *Vieillard 3263* (P), *Virot 209* (P–4 sheets), *Buchholz 1432, 1433, 1435* (†Ill); Mt. Humboldt, *Virot 343* (†P), *Virot 422* (P), *Buchholz 1575* (†Ill), *Schlechter 15329, 15330* (†BR, K, P); Mt. Koghi, *Balansa 183* (K, NY, P–4 sheets), *Franc 2324* (A, P); Mt. Dzumac, *LeRat 154, 330* (P), *2829* (K, P–2 sheets, *Franc 532* (A, †BM, †LA, NY, P, †UC); Mt. Mou, *M. de Pompéry* in 1880 (P); Montagne des Sources, *MacDaniels s.n.* (†CU); Bourare, *Cribbs 1183* (†P); Ile de Pins, *Jeanneney s.n.* (P). LOCALITY NOT INDICATED: *Muller 70* (type coll., †P–2 sheets), *Muller s.n.* (P).

CULTIVATED: United States, California, *Buchholz* in 1942 (Ill).

Orr discusses *Podocarpus gnidioides* as a New Caledonian plant among the species in his geographical area (b) Asiatic, Malayan and Polynesian, but he emphasizes its relationship to the New Zealand species. He described the hypodermal fibers as "frequently superimposed on one another" and neatly packed together to "produce a characteristic mosaic appearance." This is very striking and, on examination of transverse leaf sections, easily differentiates this species from the others in subsection D.

In 1866 Brongniart and Gris (1) described a tree which they called *Podocarpus alpina* var. *arborescens* from a *Muller* specimen collected in 1862. At the same time they described the shrub from Mt. Dore, New Caledonia, and named it *P. alpina* var. *caespitosus*. In the Paris Museum there now exist two similar *Muller* specimens, both #*70*. The herbarium labels of these give both Australia and New Caledonia as collection regions and one describes the plant as a "taxad" tree, 40 ft. high, with the habit of a *Sequoia*. It is a sterile specimen and a tag on it says "like *Taxus* New Cal." The other #*70* does not indicate habit. After almost a century, in which many collectors, notably Pancher and Vieillard, and in recent years Compton, Buchholz, Chevalier and others have made extensive

collections on New Caledonia, such a tree has not been seen again. I have examined the leaf anatomy of the first of the *Muller* specimens and do not observe any difference from that found in a large number of shrubby specimens from different mountain regions in New Caledonia. It is always characteristic. Compton (7) indicated that he could not find any difference in the external appearance of the foliage. It is now doubtful if it ever existed as a tree and it is probable that there was some confusion at the time labels were attached to the specimens.

Carrière (4) recognized the tree and the shrub as a distinct species from *Podocarpus alpinus*, naming them *P. gnidioides* with a variety *caespitosus*. Unfortunately he selected the now doubtful tree for the type and made the shrub the variety. The life history of the shrub is completely known. Since the tree habit is the only vegetative difference, buds, twigs, and leaves all being the same, it now seems most desirable to omit from the description the existence of a tree except as a mere possibility. Prof. Buchholz, when pursuing his extensive studies of New Caledonian conifers, reached the decision to drop the use of the variety *caespitosus*. This is consistent with the rules of nomenclature in that *Muller #70* is obviously the type of *P. gnidioides* and it is identical with the plant we now know.

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